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**APPARATUS AND METHOD FOR
 MONITORING AND IMPROVING THE
 ALERTNESS OF A SUBJECT**

FIELD AND BACKGROUND OF THE
 INVENTION

The present invention relates to the field of psychological data collection in general and in particular to apparatus and method for monitoring and improving the alertness of a subject.

Devices for monitoring the alertness of a subject through administering successive stimuli to the subject and analyzing his responses are known in the art. Typically, the devices are used to provide an indication when a subject displays an insufficient level of alertness to execute his routine work be it driving a vehicle, operating machinery, standing guard, etc. The indication can be provided automatically by the device if the performance level of the subject indicative of his state of alertness falls below a pre-determined baseline performance level or by a mediator administering a test. The insufficient level of subject alertness can be due to drowsiness under monotonous working conditions, mental preoccupation, the influence of alcohol or drugs, etc. Devices are known for use in a variety of environments including when operating a vehicle, within the confines of a laboratory, under field conditions, etc.

Devices are known for administering stimuli at pre-determined time intervals and at random time intervals. Furthermore, devices are known for providing stimuli at variable time intervals in response to the subject's overall performance level provided in terms of either the time taken by the subject to respond to a stimulus and/or the accuracy of the responses given by the subject. Typically, the accuracy of the responses involves the evaluation of correct responses, errors of commission when a response is given at the wrong time and errors of omission when a response is not given at all.

A common feature of the devices is that they require the subject to perform a task. The tasks can be classified into two types: discrimination level tests and cognitive tests. Discrimination level tests are characterized in that the subject has to respond to the presence or the absence of a stimulus in the form of an audible signal, a visual signal, or a tactile signal. Discrimination level tests are referred to as secondary task type tests in the sense that the subject performs the task concurrently with his primary task be it driving a vehicle, operating machinery, standing guard, etc. The devices are typically designed to automatically provide an alarm signal when the overall performance level of a subject, in terms of his response times to stimuli and his accuracy of responses, falls below a pre-determined baseline indicating that the subject is not capable of performing the task in hand.

Advantages of discrimination level tests include that they are generally quick, easy to administer, easy to evaluate, provide concurrent monitoring of subject alertness during execution of a primary task and provide automatic alarm signals when the overall performance level falls below a pre-determined baseline level. Disadvantages of discrimination level tests include that the stimulus can be of such intensity so as to cause a sudden change in the state of alertness of a subject, thereby disguising his true state of alertness, and that the discrimination level detected by the subject depends on the environment in which the test is performed.

In contrast to discrimination level test, cognitive tests are characterized in that the subject has to respond to a stimulus

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requiring the mental processing of information including recognition, recall, association, etc. before initiating a response. Most of the known cognitive tests are primary task type tests in the sense that the subject only performs that task during an interruption from his routine work. In this case, often a mediator supervises the testing of subject to ascertain which subjects display a sufficient level of alertness to execute their routine work.

Advantages of cognitive tests are that the contents and the difficulty of the tests can be readily adjusted so as to be compatible for a wide range of subjects and that subjects do not become desensitized to the tests. Disadvantages of cognitive tests include that the tests typically take a relatively long time to perform, thereby disrupting the execution of the subject's routine work, and that they are not concurrent with the routine work of the subject.

Exemplary devices known in the art are now briefly described.

U.S. Pat. No. 3,922,665 to Curry et al. discloses a device implementing discrimination level tests in which the intensity of an audio tone increases until the subject actuates a response switch to terminate the stimulus. Successive stimuli are initiated intermittently at selectively variable time intervals inversely related to the time taken by the subject to detect and to respond to each stimulus. An alarm signal is given when no response is made within a given interval after a stimulus is initiated. The device also includes an automatic stimulus level control apparatus for sampling background noise levels and adjusting the volume of the audible tone stimulus to match the background noise level. The device suffers from two main disadvantages. First, that the subject becomes desensitized to the test. Second, that the device records a higher intensity signal than detected by the subject due to the length of time it takes the subject to respond to the signal because during his response time the signal continues to increase.

Devices implementing cognitive tests are disclosed in U.S. Pat. No. 4,464,121 to Perelli, U.S. Pat. No. 4,755,140 to Rimland, and others. In the case of U.S. Pat. No. 4,464,121, the cognitive test requires that the test subject respond to numerals and symbols displayed on a numeric-symbolic display by activating one or more switches while, in the case of U.S. Pat. No. 4,755,140, the cognitive test requires the test subject respond to a particular sequence of numbers using an array of pushbutton keys having programmable variable numerals. The alertness of a subject is provided in terms of response times, the number of errors made in a test, etc. These devices suffer from the above-mentioned disadvantages of devices cognitive tests.

In summary, there is a need for apparatus and method for monitoring and improving subject alertness which combines the beneficial features of discrimination level tests and cognitive tests. In particular, there is a need for apparatus and method for monitoring and improving subject alertness while the subject continues to perform his primary task without undue disturbances.

SUMMARY OF THE INVENTION

The present invention is for apparatus and method for monitoring and improving subject alertness which combines the beneficial features of discrimination level tests and cognitive tests. The apparatus and method can be readily adapted for application in a wide range of different environments including when operating a vehicle, within the confines of a laboratory, under field conditions, etc.